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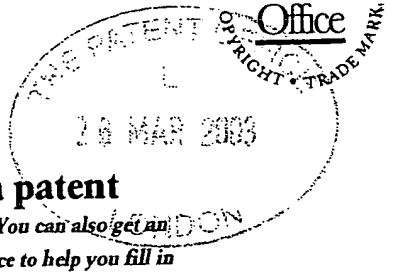

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

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1. Your reference — 26 MAR 2003 — MCM/ASB/25460

27MAR03 E795412-1 D02000
P01/7700 0.00-0306963.0

2. Patent application number
(The Patent Office will fill in this part) — 0306963.0

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

James Walker & Company Limited
Woking Business Centre
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Old Woking
Surrey GU22 8JL
United Kingdom

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — SS31223002

4. Title of the invention

A Lip Seal

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

MATHYS & SQUIRE
100 Gray's Inn Road
London WC1X 8AL
United Kingdom

Patents ADP number *(if you know it)* — 1081001

	Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number			

	Number of earlier application	Date of filing *(day / month / year)*
7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application		

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) *any applicant named in part 3 is not an inventor, or*
b) *there is an inventor who is not named as an applicant, or*
c) *any named applicant is a corporate body.*
See note (d))

YES

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	7
Claim(s)	2
Abstract	1
Drawing(s)	3 + 3

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	-
Request for preliminary examination and search *(Patents Form 9/77)*	-
Request for substantive examination *(Patents Form 10/77)*	-
Any other documents *(please specify)*	-

11. I/We request the grant of a patent on the basis of this application.

Signature Mathys & Squire Date

MATHYS & SQUIRE 26 March 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

Michael C Moir - 020 7830 0000

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A LIP SEAL

The invention relates to a lip seal, for example, in the form of an elastomeric annular ring, used either singly or in an arrangement of two or more units, to seal the space between a rotating shaft and a stationary member surrounding the shaft. Typical applications include mineral extraction and processing, shallow water dredging and tunnel boring.

Traditional sealing arrangements for highly abrasive media generally consist of a number of basic u-ring type lip seals manufactured from either a rubber proofed fabric composite material, a suitable elastomeric compound or a combination of both. In order to protect the dynamic interface between the sealing edge of the lip and the rotating shaft from excessive wear associated with the build up of abrasive material at this point, a suitable fluid, usually a grease, is pumped between the shaft and the sealing lip to wipe away the debris.

In addition to the abrasive nature of the media encountered in applications of this type, the media may be pressurized to levels far above that which a single rotary lip seal can withstand without damage. To overcome this problem, the environmental pressure is reduced in stages across a number of separate seals. To achieve this a lubricating fluid, such as grease or oil, is injected at a controlled pressure through the seal housing and lantern rings into each inter-seal cavity to provide a support to the sealing lips, reducing the differential pressure per seal to an acceptable level.

Figure 4 shows a traditional abrasive media sealing arrangement consisting of a number of specialized abrasion resistant seals **17**, facing the medium, which may be used in conjunction with standard spring energized lip seals **18**. Although these lip seals **18** are capable of sealing higher differential pressures they exhibit poor abrasion resistance. One of these **19** may face away from the medium to seal gear oil.

A suitable lubricating medium is injected though each housing port **11** and lantern

ring **20** into the inter-seal cavities **21,22,23,24** at a controlled pressure. The first port **25** is used to inject a medium at a pressure greater than environmental pressure into the first inter-seal cavity **21** in order to flush beneath the sealing lip **46** of the first seal in the arrangement **29**. Subsequent ports **26,27,28** are used to inject a medium through the lantern rings **20** and into the inter-seal cavities **22,23,24** at a pressure sufficient to support the sealing lips of the remaining seals **30,31,32,46** at a differential pressure below the maximum differential pressure for that particular design of seal.

There are serious limitations to traditional sealing systems of this type:

1) Debris can accumulate and become compacted in the groove of the seal. This limits the flexibility of the seal lip, increasing frictional heat generation and reducing the life of the seal.

2) Existing abrasive media seals are designed either with highly flexible sealing lips to accommodate large degrees of shaft offset, but reducing differential pressure capability, or less flexible lips capable of higher pressures but lower shaft offset.

3) Traditional sealing arrangements, consisting of a number of seals and separate lantern rings, require a minimum axial housing volume to be made available in the machine, dependant on environmental pressure. The greater the axial volume required, the higher the costs of manufacturing the machine.

4) Machines with a pre-determined amount of space available for a sealing arrangement will be restricted to operating at limited environmental pressures, dictated by the maximum number of seals and lantern rings that can be accommodated.

In at least its preferred embodiment, the present invention is intended to overcome the above problems.

The present invention provides a lip seal comprising resilient annular sealing means having a sealing lip adapted for sealing engagement at an end thereof with a rotatable shaft to separate a sealed region from an ambient region, and a shield coextensive with the lip on the ambient side thereof to protect the lip from the ambient region and to define a space with the lip, and means permitting the injection under pressure of fluid into the space, the shield having an edge disposed such that the fluid exits the space by passing across the end of the lip.

The present invention also provides a lip seal comprising resilient annular sealing means having a sealing lip adapted for sealing engagement at an end thereof with a rotatable shaft and a shield lip, in use the lips being normally closed, and means for injecting fluid between the closed lips at sufficient pressure to cause the lips to open during use to allow the fluid to flow towards the end of the sealing lip.

A preferred embodiment consists of an annular lip seal, held statically in a rigid housing bore through a combination of an interference fit on the outer diameter of the seal and a designed axial compression of the seal. Sealing of the rotating shaft is effected through an interference fit of the primary sealing lip on the shaft.

The requirement for a continuous purge of a suitable medium to remove abrasive debris from the sealing lip/ shaft interface is met by an internal flush system. The medium is injected through the centre of the seal and vented between the primary sealing lip and a secondary valve or vent lip which acts as a flexible valve or throttle, normally in positive contact with the primary sealing lip. These two lips meet in such a way that the venting occurs in a region adjacent to the sealing lip/ shaft interface.

The vent lip is forced against the primary sealing lip under normal operating conditions, forming a water-tight seal. This does not allow abrasive debris to reach the internal envelope of the seal, protecting the groove of the primary sealing lip from the ingress and subsequent compaction of the debris. The geometry of the top surface of the primary sealing lip is designed such that the vent lip rides smoothly over it under shaft offset conditions maintaining contact at all times.

The self-venting functionality of the invention can facilitate a reduction in the number of units required to seal against a given pressure when compared with traditionally vented systems. Traditional arrangements require the venting medium to be introduced through a lantern ring into the cavity between the primary and secondary seal. In this way, the medium may be pumped underneath the sealing lip of the primary seal at a pressure sufficient to overcome both the environmental pressure acting on the sealing lip and also the interference between the sealing lip and the shaft. The main implication of this venting method is that the pressure in the first inter-seal cavity must be greater than the environmental pressure to achieve venting. This higher pressure must then be stepped down to zero across a number of subsequent seals, at an acceptable differential pressure per unit. The invention employs an internal venting system. This means that the medium injected into the first inter-seal cavity need only be at a pressure high enough to support the sealing lip of the primary sealing lip onto which the pressure of the venting medium, being injected through the seal, is acting. The pressure in the first inter-seal cavity will therefore be significantly lower than the environmental pressure and dependant upon the differential pressure capability of the primary seal.

As the pressure required in the first inter-seal cavity is lower, so fewer seals are required to step it down to zero. For a given environmental pressure, fewer units will be required than would be for a traditional sealing arrangement. This has the benefit of reducing equipment/ machine manufacturing costs and allowing existing machines to be operated at higher environmental pressures with only minor modification.

In traditional abrasive media seal designs the lip can be very flexible to accommodate high levels of shaft offset. These long, flexible sealing lips present a large area to applied fluid pressure. The sealing lips may be flattened onto the shaft if a modest pressure is exceeded, increasing contact area and frictional heat generation. This could lead to premature seal failure and so maximum differential pressures are strictly limited. The invention retains the shaft offset accommodation of the long, flexible lip design, while reducing the area exposed to applied fluid

pressure – the vent lip presenting a much smaller area than the primary sealing lip. This allows a higher differential pressure per seal.

The metallic rings used to separate the seals in a traditional sealing arrangement must contain the grooves and holes necessary to carry the injected medium from the housing into the inter-seal cavity. These design restrictions impose a minimum axial depth on these rings. The rings which separate the seals in an arrangement containing multiple units of the invention are essentially spacer rings, containing no holes or grooves, and so the axial length of these rings may be reduced significantly, saving on axial space and therefore manufacturing costs.

The reinforced elastomeric compound preferably utilized in the invention resists the extension of the seal under its own weight during fitting. This can occur at larger diameters where the seal diameter to cross-sectional area ratio is high. Unlike traditional rubber proofed fabric composite materials, this reinforced elastomeric compound can be easily joined to form complete endless rings when seal diameters are so large that manufacturing limitations allow only split seals to be moulded. This can offer a significant benefit over large abrasive media seals containing rubber proofed fabric which can tend to split during fitting or in service due to join weakness.

Other advantageous features are illustrated in the dependent claims, the description given below and the appended drawings.

Preferred features of the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 shows a cross section of an annular seal;

Figure 2 shows a cross section of the seal fitted into a suitable housing;

Figure 3 shows a plan view demonstrating how the internal ports would typically be

distributed;

Figure 4 shows a typical traditional sealing arrangement for a high pressure abrasive medium application; and

Figure 5 shows a sealing arrangement for the same high pressure application using the seal of Figure 1.

With reference to Figure 1, the invention consists of a two-piece annular ring **1**, one component **2** being manufactured from a suitable elastomeric compound and the second **3** from a reinforced elastomeric compound.

The elastomeric component **2** incorporates the primary sealing lip **4** which is an interference fit on the shaft **5**. The reinforced elastomeric component **3** is securely fixed to this by a flange and groove **1A** and incorporates a secondary vent lip **6** which encloses a groove **7** of the primary sealing lip **4** when fitted in a housing **12**. The inner diameter of the vent lip **8** rests radially close to the sealing edge **9** of the primary lip **4** when fitted to the shaft.

On the outer diameter of the seal is located an endless circumferential groove **10**. This is designed to coincide axially with ports **11** in the seal housing **12** through which a suitable medium is injected at a controlled pressure. This medium is then allowed to flow around this circumferential groove **10**, and through equally spaced ports **13** within the body of the seal to allow the medium to flow circumferentially around the enclosed space formed by the groove **7** and the lips **4, 6**. The pressure forces the vent lip **6** to flex allowing the medium to flow into the sealing zone **14**, removing abrasive debris. The body of the ring **1** is retained between a front plate **15** and a spacer ring **16**.

For a sealing arrangement comprising multiple units of the invention three forward facing seals **33,34,35** may be provided in addition to one rear facing unit **36** to seal gear oil, as per Figure 5. A suitable medium is injected through the primary seal **33**, via the first housing port **37** at a pressure above environmental pressure to effect a

flush. Subsequent ports **38,39** are used to inject a lubricating medium through the secondary and tertiary seals **34,35** and into the inter-seal cavities **41,42** to support the sealing lips **4** of the primary and secondary seals **33,34**. The last port **40** is used to introduce an amount of non-pressurized lubricating medium into the inter-seal cavity **43** to aid lubrication of the tertiary forward facing seal **35** and the rear facing seal **36**.

The functionality of the invention, in addition to the simplified, shallower spacer rings **16**, has enabled the housing length **44** (figure 4) required for a traditional arrangement at a given environmental pressure to be reduced significantly as seen at **45** (figure 5) for a sealing arrangement based upon the invention, at the same external pressure.

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

CLAIMS

1. A lip seal comprising resilient annular sealing means having a sealing lip adapted for sealing engagement at an end thereof with a rotatable shaft to separate a sealed region from an ambient region, and a shield coextensive with the lip on the ambient side thereof to protect the lip from the ambient region and to define a space with the lip, and means permitting the injection under pressure of fluid into the space, the shield having an edge disposed such that the fluid exits the space by passing across the end of the lip.

2. A lip seal according to Claim 1, wherein, during normal use, the shield contacts the sealing lip proximate the end thereof, the fluid being injected at sufficient pressure to cause the shield to flex to allow the fluid to flow towards the end of the sealing lip.

3. A lip seal according to Claim 1 or 2, wherein the sealing means comprises a first resilient annular member having said sealing lip and, attached to the first annular member, a second resilient annular member having said shield.

4. A lip seal according to Claim 3, wherein the second annular member is formed from a reinforced elastomer.

5. A lip seal according to any preceding claim, wherein the injection means is arranged to inject fluid between the shield and a grooved portion of the sealing means which defines in part the sealing lip.

6. A lip seal according to any preceding claim, wherein the sealing means comprises at least one port extending therethrough to the external diameter of the sealing means and through which the fluid is injected.

7. A lip seal according to any preceding claim, wherein the sealing means

comprises an outer diameter body portion from which the lip and shield depend and which is adapted for retention within a housing of a bore for the rotatable shaft.

8. A lip seal according to Claims 6 and 7, wherein the at least one port extends through the body portion of the sealing means.

9. A lip seal comprising resilient annular sealing means having a sealing lip adapted for sealing engagement at an end thereof with a rotatable shaft and a shield lip, in use the lips being normally closed, and means for injecting fluid between the closed lips at sufficient pressure to cause the lips to open during use to allow the fluid to flow towards the end of the sealing lip.

10. A seal assembly comprising a plurality of lip seals according to any preceding claim axially spaced along a bore for the rotatable shaft.

11. A lip seal substantially as herein as herein described with reference to Figure 2 of the accompanying drawings.

12. Use of a pressurized flow of fluid directed along a sealing lip towards an end thereof in sealing engagement with a rotatable shaft to remove debris accumulated thereat.

ABSTRACT

A lip seal comprises resilient annular sealing means 2, 3, having a sealing lip 4 adapted for sealing engagement at an end 9 thereof with a rotatable shaft 5 and a valve lip 6, the lips being, in use, normally closed, and means 11, 13, for injecting fluid into a space 7 between the closed lips 4, 6 at sufficient pressure to cause the lips to open during use to allow the fluid to flow towards the end 9 of the sealing lip 4.

(Figure 1)

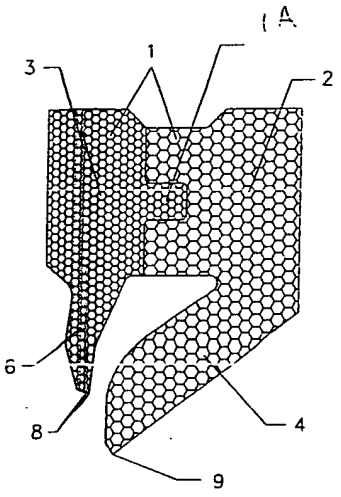

FIGURE 1

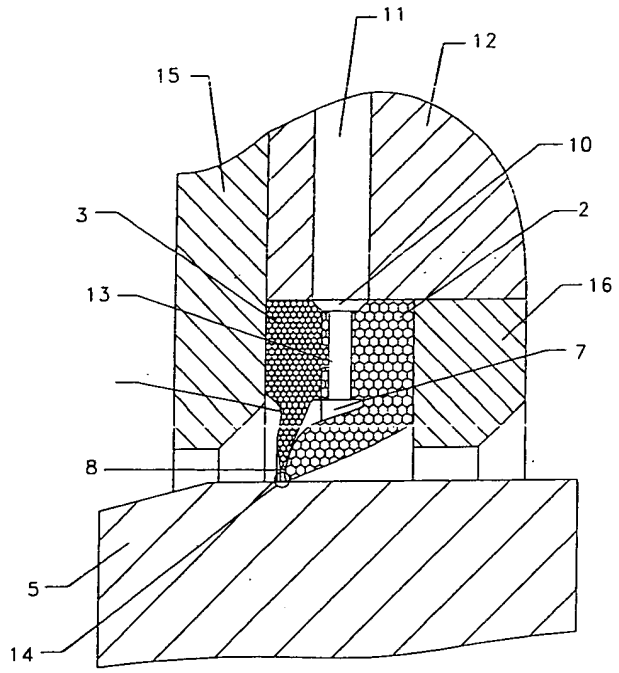

FIGURE 2

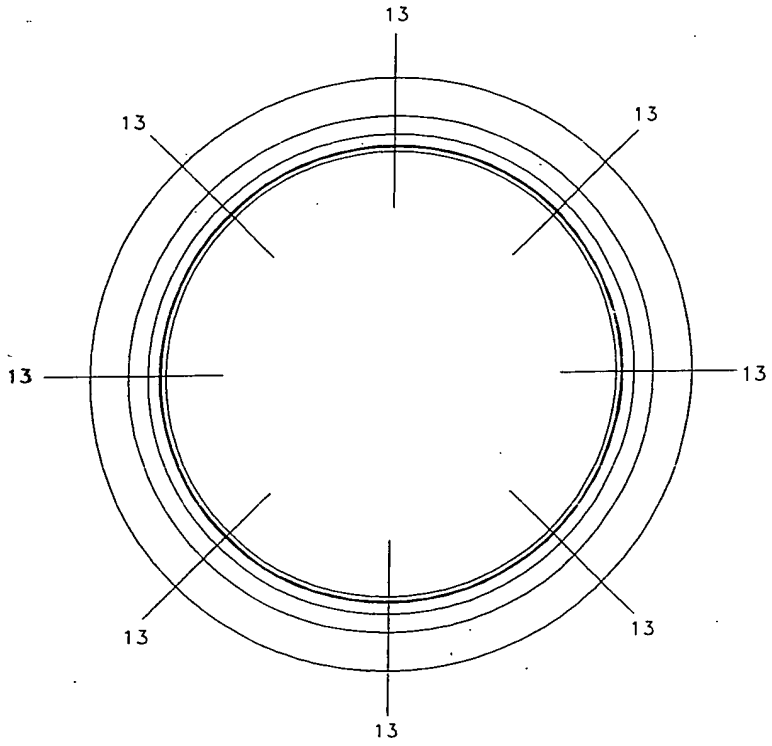

FIGURE 3

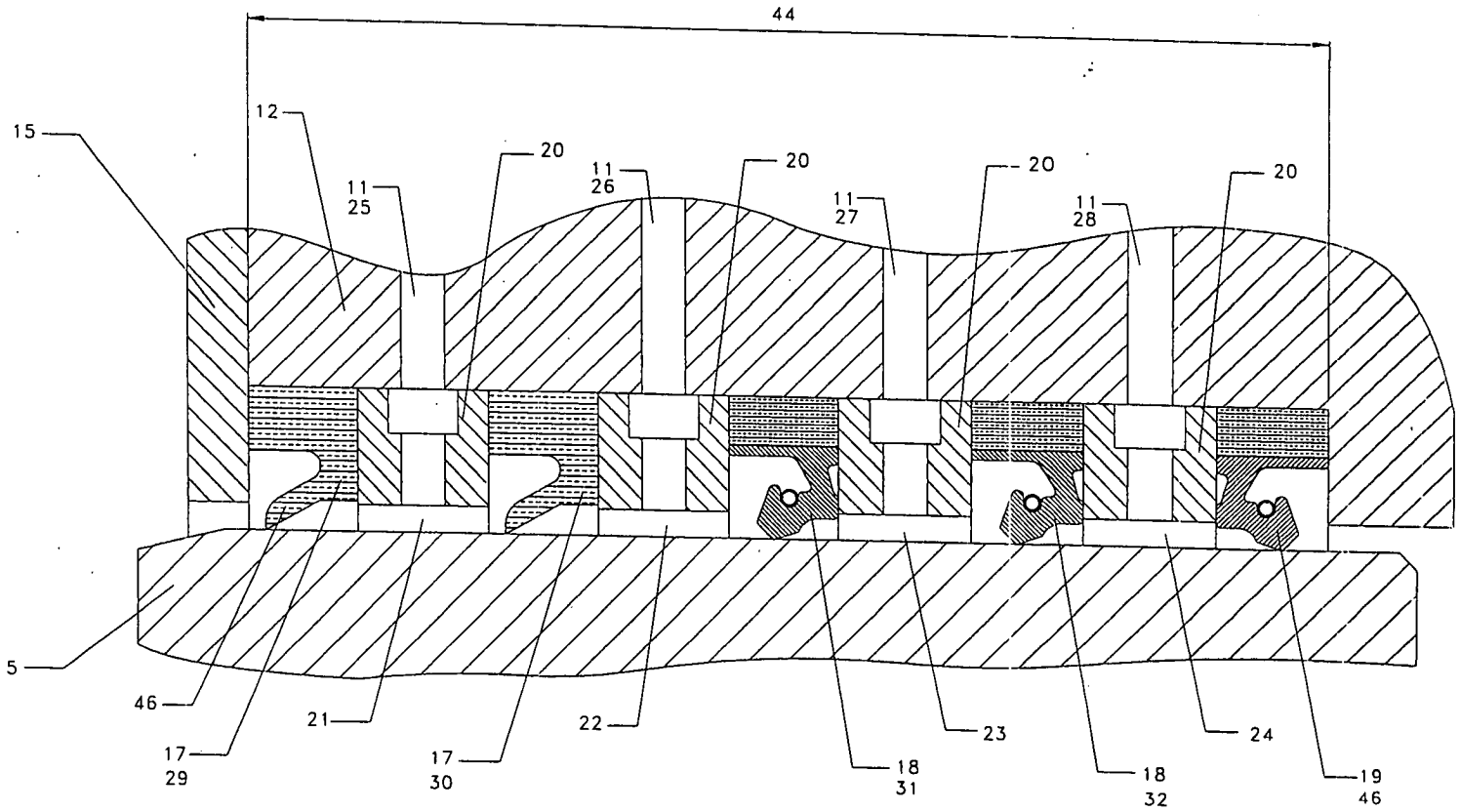
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FIGURE 4

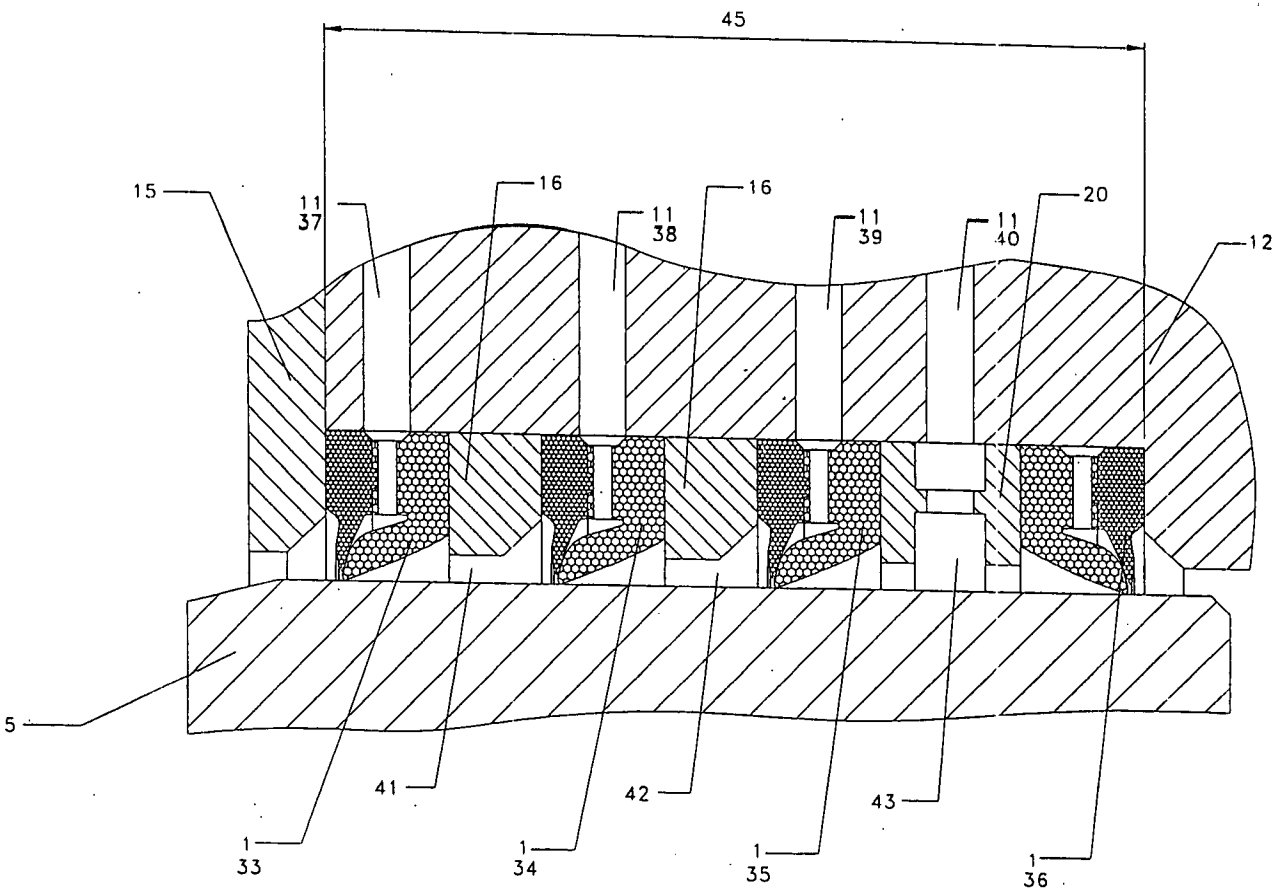

FIGURE 5